# BIOGRAPHIES OF SOME WORMS.

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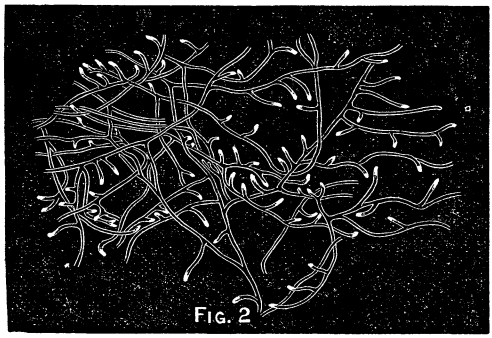
## VI. THE POLYZOA.

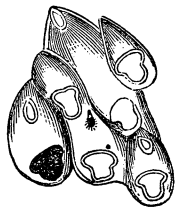
The Polyzoa or moss animals derive their common name from their resemblance to mosses. For example, the fresh water *Frederi-*

Fig. 185.




Fresh water Polyzoon.

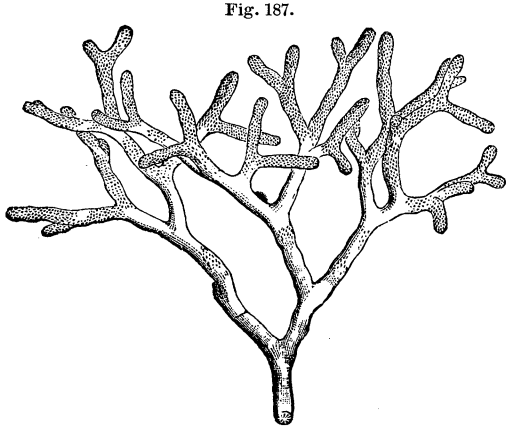
Fig. 186.



Sea mat.

*cella Walcottii* (Fig. 185, after Hyatt) would easily be mistaken for moss growing on a submerged stick. The marine species have small-

Fig. 187.



Branching Marine Polyzoon.

er cells and form mat-like encrustations, as in Membranipora (Fig. 186, cells enlarged); or as in *Myriozoum subgracile* (Fig. 187),

they form a coral-like branching mass. On magnifying these cells when the animal is alive and extended from its cell, each polypide, as it is called, appears with its crown of tentacles somewhat like a Sabellid worm. This crown of tentacles surrounds the mouth, which leads by an œsophagus into the throat and a stomach, the latter bent so that the intestine beyond ends very near the mouth; the polypide is thus bent on itself within the cell (cystid) and its body is drawn in and out by muscles. Attached to the end of the fold of the stomach is a cord (funiculus) holding the ovary in place, which extends back to the end of the cystid, as we may call the cell.

Allman regards the polypide and cystid as separate individuals. Now in confirmation of this view we have the singular genus Loxosoma, which is like the polypide of an ordinary Polyzoan, but does not live in a cell. On the other hand, we know of no cystids which are without a polypide (Nitsche).

The affinities of the Polyzoa to the worms are quite decided. In the Phoronis worm, which is allied to Sipunculus, we have the alimentary canal flexed, and the anus situated near the mouth. The Polyzoa have but a single pair of nerve ganglia, and in some cases a tubular heart. The fresh water species are the higher, and are called Phylactolæmata; the marine species are termed Gymnolæmata. All the Polyzoa are hermaphrodite, the ovaries and male glands residing in the same cystid.

*Development of the Polyzoa.*—Remembering that the cystids stand in the same relation to the polypides as the hydroids to the medusæ, as Nitsche insists, we may regard the polypides as secondary individuals, produced by budding from the cystids. The large masses of cells forming the moss animal, which is thus a compound animal, like a coral stock, arises by budding out from a primary cell. The budding process begins in the endocyst, or inner of the double walls of the body of the cystid, according to Nitsche, but according to an earlier Swedish observer, F. A. Smitt, from certain fat bodies floating in the cystid.

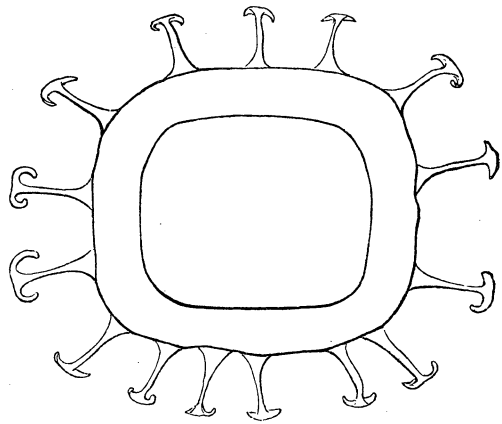
Nitsche has observed the life history of *Flustra membranacea*. He has traced the budding of one cell or zoœcium (representing the cystid individual) from another. During this process the polypide within decays, leaving as a remnant the so-called "brown body," regarded by Smitt as a secretion of the endocyst and germ of a new polypide. After the loss of its first polypide, it can pro-

duce a new one by budding from the endocyst on the side of the stomach. In Loxosoma, young resembling the adult, bud out like polyps.

Nitsche does not regard this budding process as an alternation of generations, but states that in Polyzoa of the family Vesiculariidæ, this may occur, as in them some cystids form the stem, and others (the zoœcia) produce the eggs.

The Polyzoa produce winter and summer eggs, the winter eggs, called *statoblasts*, being protected by a hard shell. Fig. 188, after

Fig. 188.

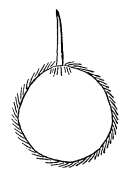


Egg of Pectinatella magnifica.

Hyatt, represents the winter egg of *Pectinatella magnifica*, with spines. These winter eggs crowd the zoœcia, and may be found in them after the polypides have decayed.

Grant first described the ciliated young of the Polyzoa. The Swedish naturalists, Lovén and Smitt, have described the development of the young *Lepralia pallasiana*, which, after passing through a true morula condition, issues from the egg as a flattened ciliated sphere with a single band of larger cilia surrounding one end.

Fig. 189.



Polyzoon larva.

Our figure (189) is copied from Claparède's memoir, and represents the larva of *Bugula avicularia* immediately after escaping from the egg. After swimming about for a while as a spherical ciliated larva, with a bunch of larger cilia (flagellum) at one end, it elongates, looses its cilia and

flagellum, and soon the polypide grows inside, the stomach and tentacles arise, and finally the polypide is formed.

In conclusion, the Polyzoa increase (a) by budding, (b) by normal eggs and winter eggs. In reproducing from eggs the young passes through:

1. Morula state.
2. Trochosphere, much as in certain worms and mollusks, attaining the
3. Adult condition (zoœcium).

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——— Beiträge zur Kenntniss der Bryozoen. (Siebold und Kölliker's Zeitschrift, 1871.)

*Claparède.* Beiträge zur Anatomie und Entwicklungsgeschichte der Seebryozoen. (Siebold und Kolliker's Zeitschrift, 1870.)

Consult also papers by Grant, Lovén, Huxley, Hyatt and Hincks.

## VII. THE BRACHIOPODA.

While the Brachiopods have been regarded by many as closely related to the Polyzoa, there are many features, as insisted on by Prof. Morse, which closely ally them to the Chætopod worms. In his treatise "On the systematic Position of the Brachiopoda,"[1] Morse has given conclusive reasons for removing them from the mollusks and placing them among the worms, and even, in his opinion, among the Chætopods, the highest division of worms. He thus, after giving the anatomical facts in his view sustaining his position, concludes that ancient Chætopod worms culminated in two parallel lines, on the one hand, in the Brachiopods, and on the other, in the fixed and highly cephalized Chætopods.

On the other hand Mr. A. Agassiz, swayed by their relationship to the Polyzoa, remarks that "the close relationship between Brachiopods and Bryozoa cannot be more fully demonstrated than by the beautiful drawings on Pl. v., of Kowalevsky's history of Thecidium. We shall now have at least a rational explanation of the homologies of Brachiopods, and the transition between such types as Pedicellina to Membranipora and other incrusting Bryozoa, is readily explained from the embryology of Thecidium. In

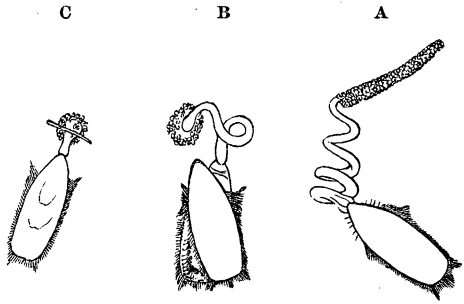
[1] Proceedings of the Boston Society of Natural History, xv, 1873.

fact, all incrusting Bryozoa are only communities of Brachiopods, the valves of which are continuous and soldered together, the flat valve forming a united floor, while the convex valve does not cover the ventral valve, but leaves an opening more or less ornamented for the extension of the lophophore."[1]

In his first paper on the "Earlier Stages of the Terebratulina" Morse had shown the same relationship between the young Brachiopod and the Pedicellina.

The two commonest forms on our coast are the *Terebratulina septentrionalis*, found attached to stems or shells in the seas of New England, while the *Lingula pyrimidata* (Fig. 190, A, with the peduncle perfect, retaining a portion of the sand tube; B, showing the valves in motion, the peduncle broken and a new sand case be-

Fig. 190.




Lingula pyrimidata. After Morse.

ing formed; C, the same with the peduncle broken close to the body, after Morse) is common in sand between tide marks, from North Carolina to Florida. It is usually free, but sometimes attached.

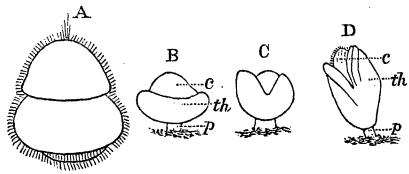
*Development of the Brachiopods.* The life-history, from the time that it leaves the egg until it attains maturity, of our common lampshell, *Terebratulina septentrionalis*, has been told by Prof. Morse. Before his account appeared our knowledge was extremely fragmentary. Morse believes that in all the Brachiopods the sexes are separate. The eggs (Fig. 192, A), he says, as in the Annelida, when arrived at maturity, escape from the ovaries into the general cavity of the body, and are thence gathered up by the segmental organs, or oviducts, and discharged into the surrounding water. Whether they are fertilized after they leave the

[1] Amer. Journ. Sc. and Arts, Dec., 1874.

parent or before, is not settled. In a few hours after they are discharged the embryos hatch and become clothed with cilia. The earliest stages of the egg of Brachiopods before the larva hatches, were studied by Kowalevsky after the publication of Morse's researches. The Russian zoologist observed in the egg of Thecidium the total segmentation of the yolk (also observed in Terebratulina by Morse), until a blastoderm (ectoderm) is formed around the central segmentation cavity, which contains a few cells. The similar formation of the blastoderm was seen in Argiope, but not the morula stage. After this the ectoderm invaginates and a cavity is formed, opening externally by a primitive mouth. The walls of this cavity now consist of an inner and outer layer (the endoderm and ectoderm). This cavity eventually becomes the digestive cavity of the mature animal. After this the development goes on as previously described by Morse, Kowalevsky's discoveries confirming those of the former observer.

In Terebratulina Morse observed that the oval ciliated germ became segmented, dividing into two and then three rings, with a tuft of long cilia on the anterior end (Fig. 191, A). In this stage the larva is quite active, swimming rapidly about in every direction.

Fig. 191.




Larval stages of Terebratulina.

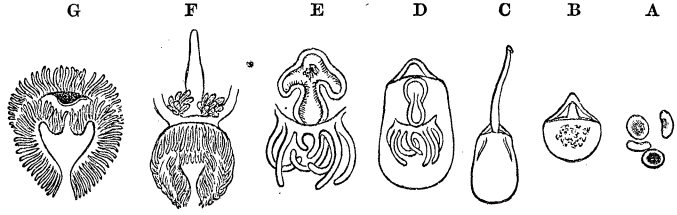
Soon after, the germ looses its cilia and becomes attached at one end as in Fig. 191, B (*c*, cephalic segment; *th*, thoracic segment; *p*, peduncular or caudal segment). The thoracic ring now increases much in size so as to partially enclose the cephalic segment, as at Fig. 191, C. The form of the Brachiopod is then soon attained, as seen in Fig. 191, D, in which the head (*c*) is seen projecting from the two valves of the shell (*th*), the larger being the ventral plate.

The hinge margin is broad and slightly rounded when looked at from above; a side view however, presents a wide and flattened area, "as is shown in some species of Spirifer, and the embryo for a long time assumes the position that the Spirifer must have assumed." Before the folds have closed over the head, four bundles of bristles appear; these bristles are delicately barbed like those of larval worms. The arms, or cirri, now bud out as two promi-

nences, one on each side of the mouth. Then as the embryo advances in growth the outlines remind one of a Leptæna, an ancient genus of Brachiopods, and in a later stage the form becomes "quite unlike any adult Brachiopod known."

The deciduous bristles are then discarded, and the permanent ones make their appearance, two pairs of arms arise, and now the shell in "its general contour recalls Siphonotreta, placed in the family Discinidæ by Davidson, a genus not occurring above the Silurian." No eye spots could be seen in Terebratulina, though in the young Thecidium they were observed by Lacaze-Duthiers. The young Terebratulina differs from Discina of the same age in being sedentary, while, as observed by Fritz Müller, the latter "swims freely in the water some time after the dorsal and ventral plates, cirri, mouth, œsophagus and stomach have made their appearance." Discina also differs from Terebratulina in having a long and extensible œsophagus and head bearing a crown of eight cirri or tentacles. Regarding the relations of the Brachiopods with the Polyzoa, Morse suggests that there is some likeness between the embryo Brachiopod, and the free embryo of Pedicellina. Fig. 192, B, represents the Terebratulina when in its form it recalls Megerlia or Argiope. C represents a later Lingula-like stage. "It also suggests," says Morse, "in its movements the nervously acting Pedicellina. In this and the several succeeding stages, the mouth points directly backward (forward of authors), or away

Fig. 192.




Later stages of Terebratulina.

from the perpendicular end (D) and is surrounded by a few ciliated cirri, which forcibly recall certain Polyzoa. The stomach and intestine form a simple chamber, alternating in their contractions and forcing the particles of food from one portion to the other." Figure 192, E, shows a more advanced stage, in which a fold is seen on each side of the stomach; from the fold is developed the

complicated liver of the adult, as seen in E, which represents the animal about an eighth of an inch long. The arms (lophophore) begin "to assume the horse-shoe-shaped form of Pectinatella and other high Polyzoa. The mouth at this stage begins to turn towards the dorsal valve (ventral of authors), and as the central lobes of the lophophore begin to develop, the lateral arms are deflected as in F. In these stages (G) an epistome[1] is very marked, and it was noticed that the end of the intestine was held to the mantle by an attachment, as in the adult, reminding one of the *funiculus* in the Phylactolæmata" (Polyzoa). Turning now to Kowalevsky's memoir, he shows, according to Mr. A. Agassiz, that the larvæ of Brachiopods are strikingly like those of the Annelides. "The homology between the early embryonic stages of Argiope with well known Annelid larvæ is most remarkable, and the resemblance between some of the stages of Argiope figured by Kowalevsky and the corresponding stages of growth of the so-called Lovén type of development among Annelides is complete. The number of segments is less, but otherwise the main structural features show a closeness of agreement which will make it difficult for conchologists hereafter to claim Brachiopods as their special property. The identity in the ulterior mode of growth between the embryo of Argiope and of Balanoglossus, in the Tornaria stage, is still more striking. We can follow the changes undergone by Argiope while it passes through its Tornaria stage, if we may so call it, and becomes gradually, by a mere modification of the topography of its organs, transformed into a minute pedunculated Brachiopod, differing as far from the Tornaria stage of Argiope as the young Balanoglossus differs from the free swimming Tornaria. In fact, the whole development of Argiope is a remarkable combination of the Lovén and of the Tornaria types of development among worms."

At the close of his first memoir Morse again insists on the close relationship of the Brachiopods and Polyzoa; these views, taken with his later views as to the close relationship of Lingula with the Chætopod worms, show how intimately the Polyzoa and Brachiopods are bound together with the Annelides.

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[1] The free lip seemed to perform all the functions pertaining to the epistome in the higher Polyzoa, and we find it on the inner bend of the arms, as in the Polyzoa, though not occupying the same homological position in regard to the flexure of the intestine." Early stages of Terebratulina, p. 34.

It will be seen that neither in the Polyzoa nor Brachiopods are there any true molluscan characters, nothing homologous with the foot, the shell gland or odontophore. The Brachiopods should in our opinion be, perhaps, united with the Polyzoa and form a group lower but sub-parallel with the Annelides. The Brachiopods, from the facts afforded by Morse and others, have neither such a nervous system or respiratory or circulating organs, or an annulated body, as would warrant their union with the Chætopods. He has fully proved that they are a synthetic type, combining the features of different groups of worms, and this fact apparently forbids their being regarded as a group of Chætopods. Looking at the subject from an evolutional point of view, we should be inclined to regard the Brachiopods and Polyzoa as derived from common low vermian ancestors, while the Chætopod worms probably sprang independently from a higher ancestry.

To sum up, the Brachiopods pass through

1. A Morula state.

2. A free swimming, ciliated Gastrula condition, formed by invagination of the ectoderm.

3. Free swimming larval annulate Cephulala stage, combining the characters of the larva of Nareda and of Tornaria the larva of Balanoglossus.

LITERATURE.

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